

The boundary layer Amazonian aerosol population

A combined Lagrangian-Cloud-Resolving-Model approach

Annica Ekman¹, Radovan Krejci², Peter Tunved²

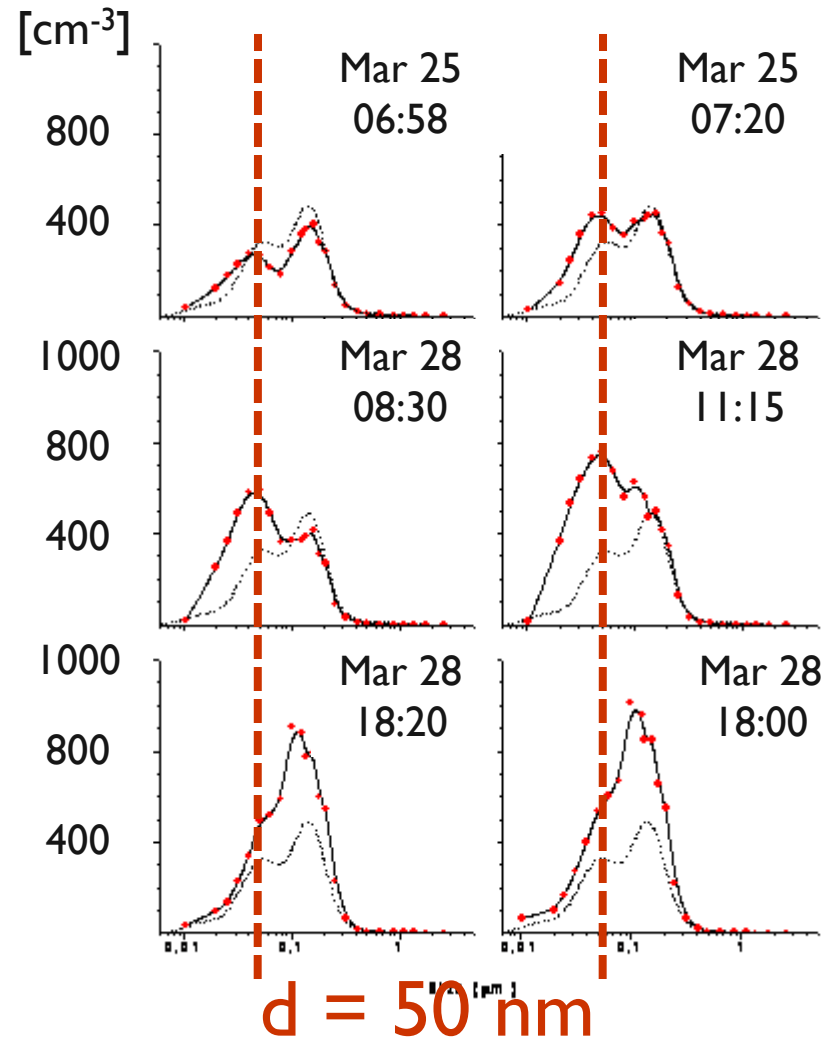
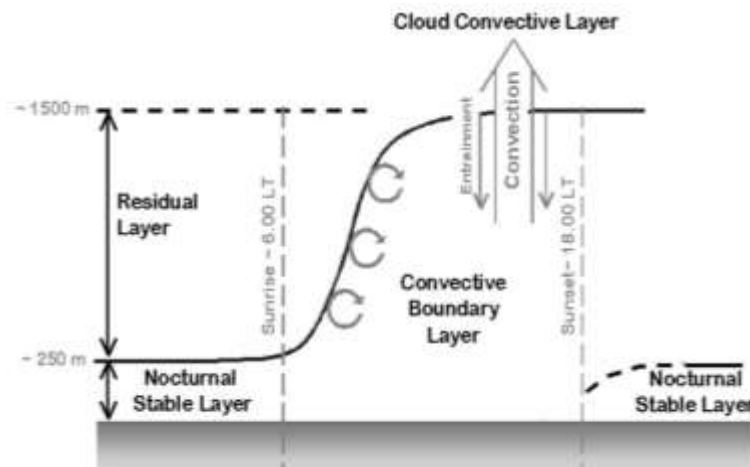
¹) Department of Meteorology, Stockholm University, Sweden

²) Department of Applied Environmental Science, Stockholm University, Sweden

Acknowledgements: Chien Wang, LBA-CLAIRE 98 team

Background

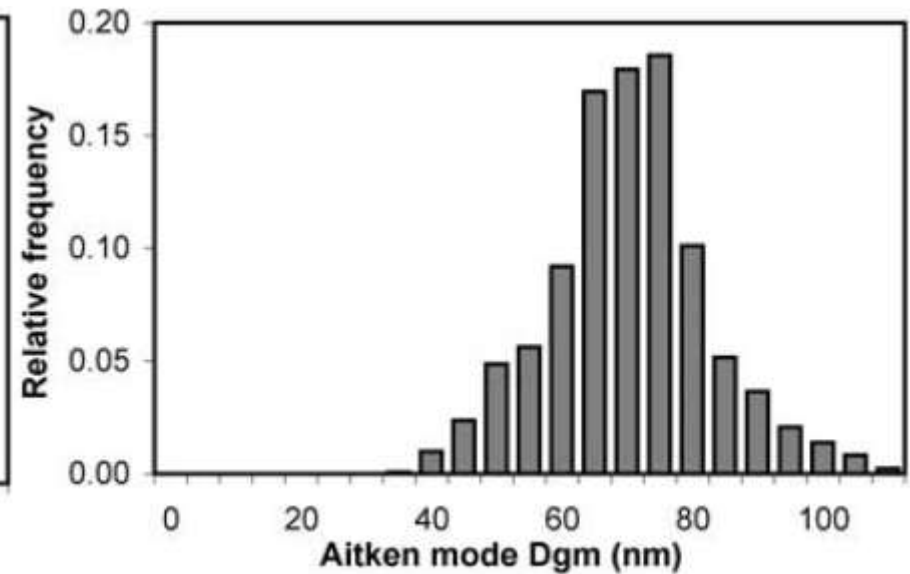
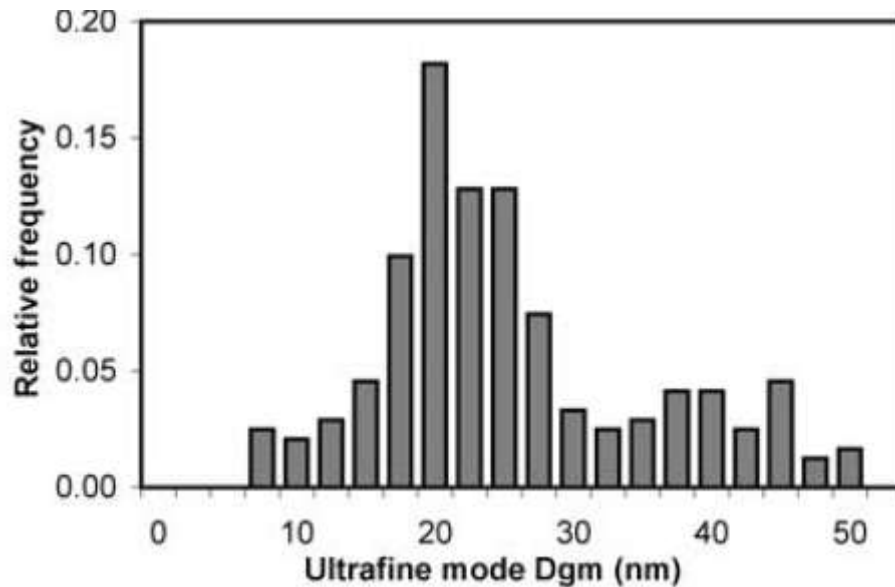
- Aerosols with $d \sim 40$ to 80 nm are generally observed in the Amazon BL during the wet season



Zhou et al. (2002) Roberts et al. (2002), Rissler et al. (2004), Krejci et al. (2005)

Background

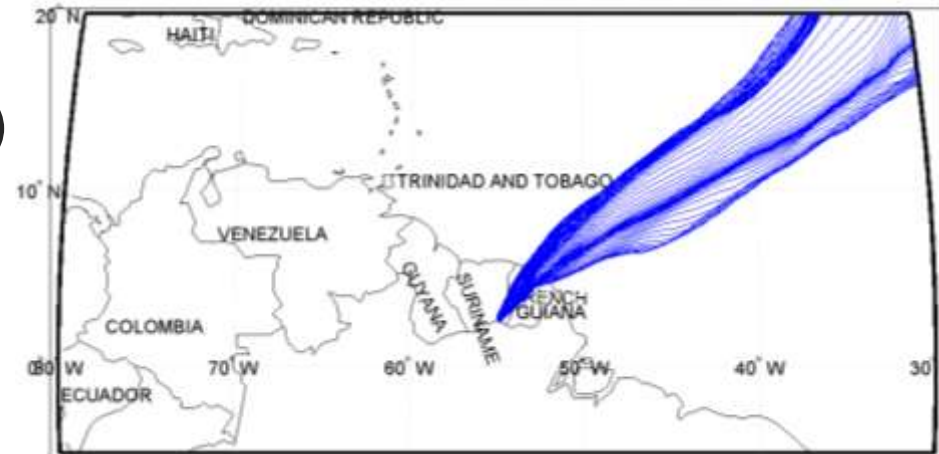
- Aerosols with $d \sim 20$ nm are frequently observed as well



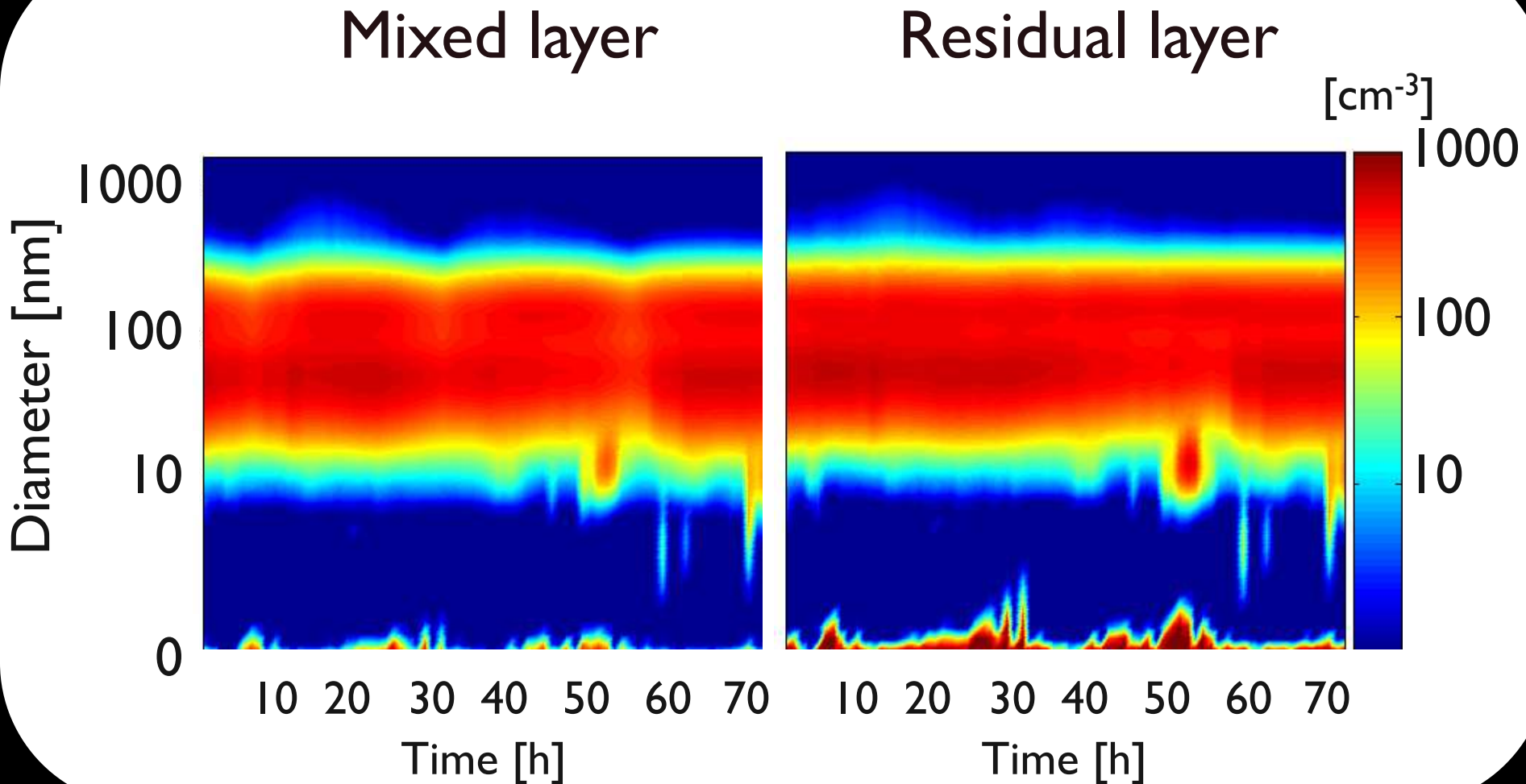
Zhou et al. (2002)

Can new aerosols be formed in the ML/RL over the Amazon rain forest?

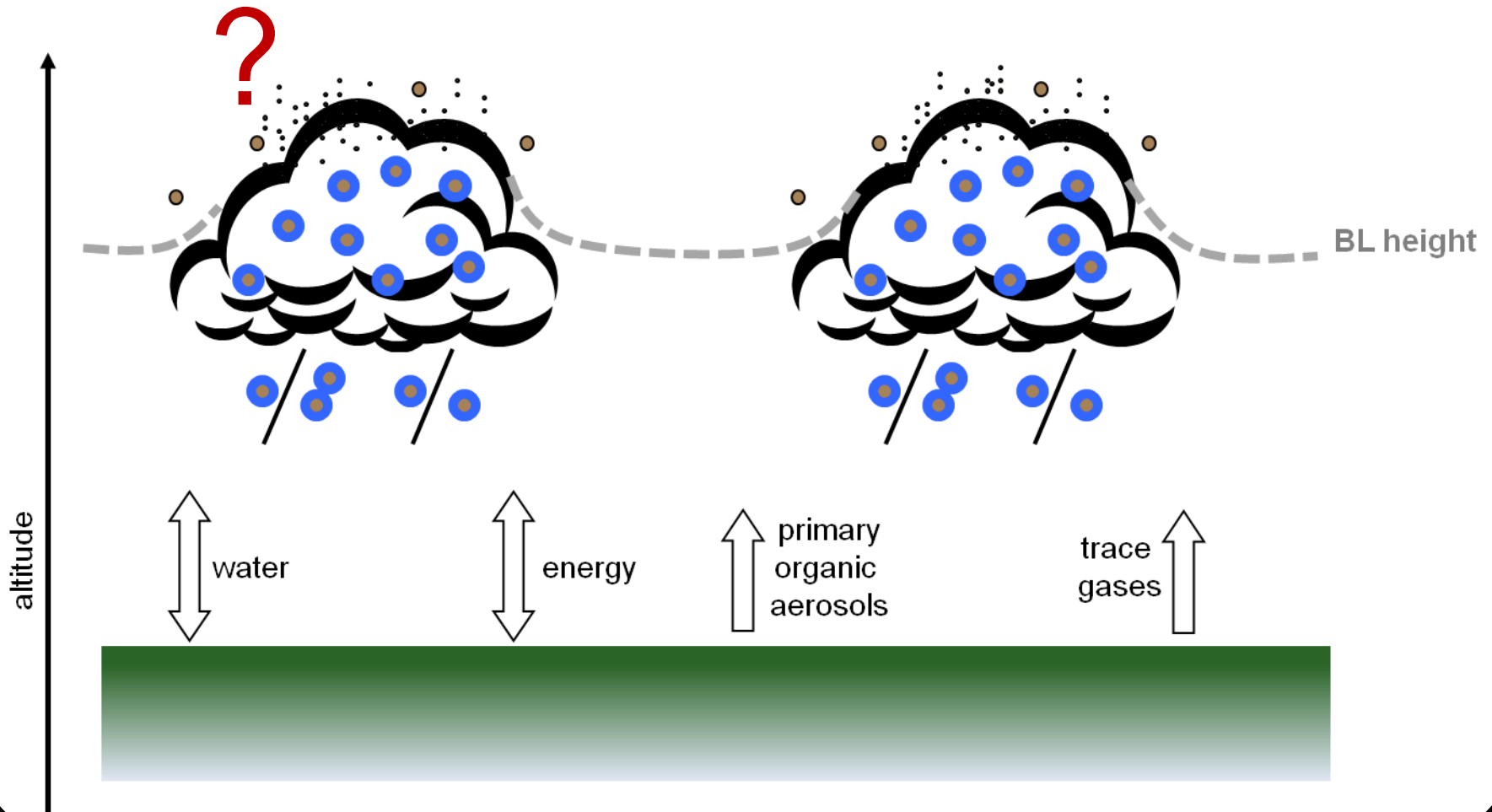
- Lagrangian chemistry-aerosol box-model (Tunved et al. 2006) calculations following 60-hour trajectories (March 25-28, 1998)
- Isoprene emissions: $2.1 \text{ mg C hr}^{-1} \text{ m}^{-2}$ (Kuhn et al., 2007)
- Monoterpene emissions $0.39 \text{ mg C hr}^{-1} \text{ m}^{-2}$ (Kuhn et al., 2007)
- DMS emissions dependent on T and wind speed (AEROCOM)



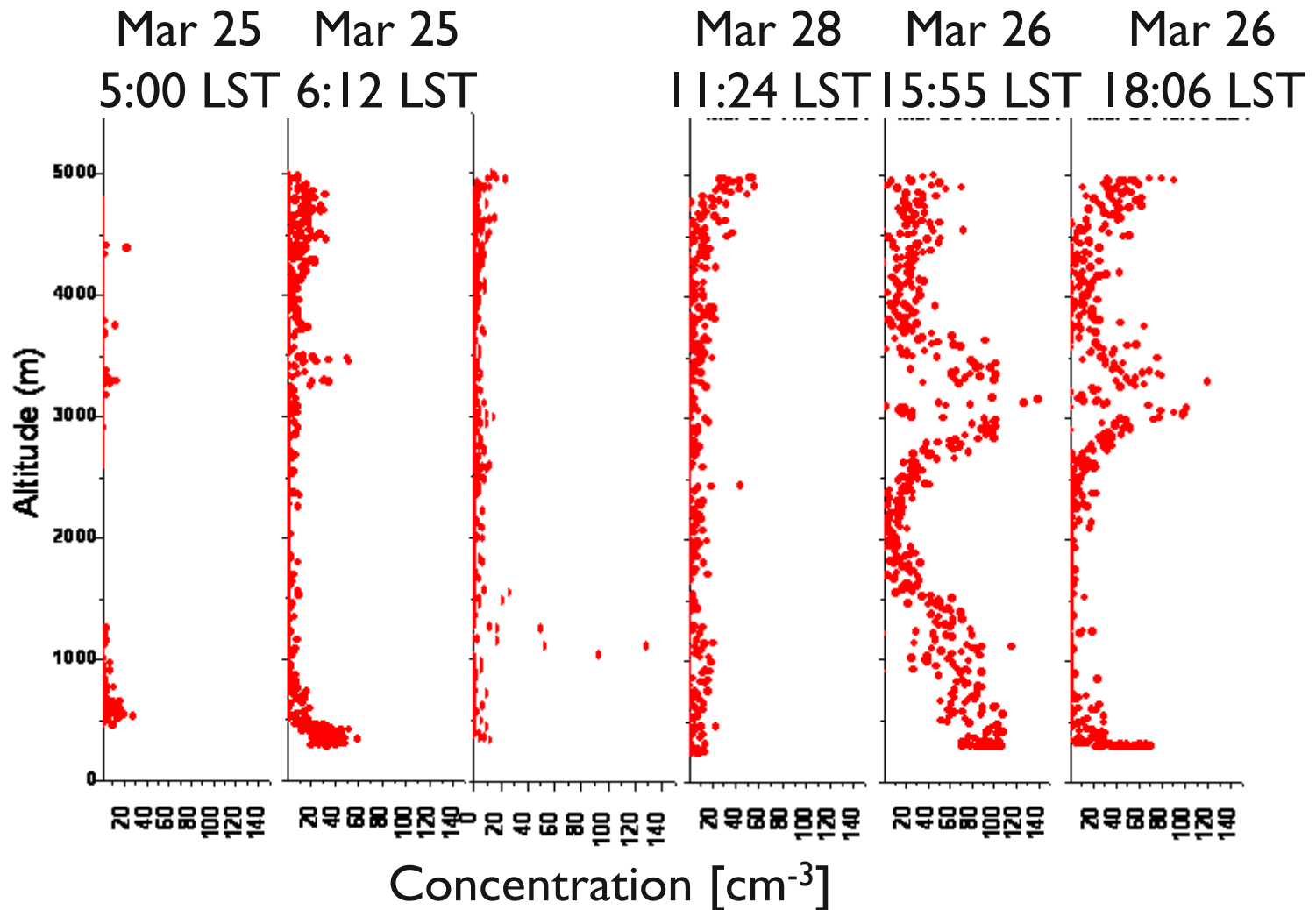
Can new aerosols be formed in the ML/RL over the Amazon rain forest?



Can new aerosols be formed within shallow convection?



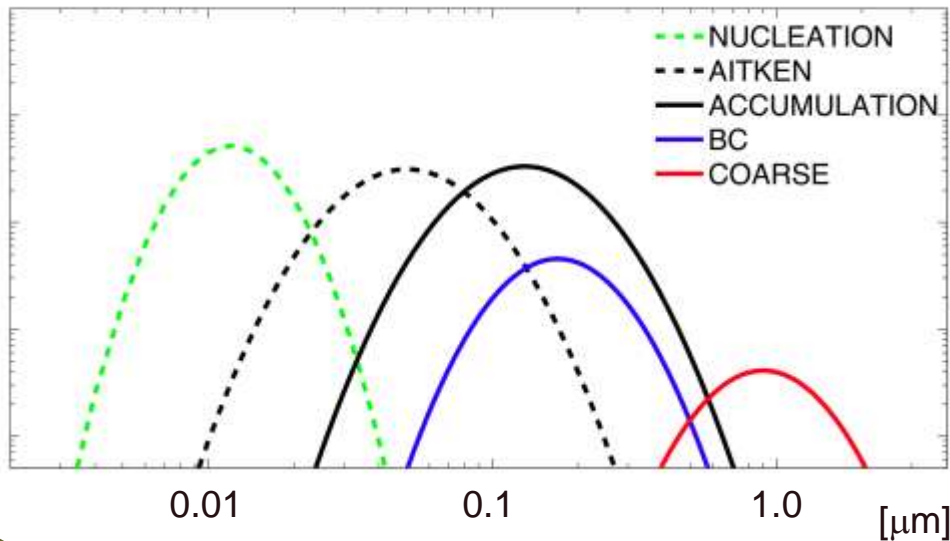
Vertical UFCN ($0.006 - 0.018 \mu\text{m}$, STP) profiles over southern Surinam (LBA-CLAIRE 98)



Cloud-Resolving Model (CRM)

Aerosols
(provide IN & CCN)

MODEL AEROSOL MODES



- Activation nucleation,
 - $A=2 \times 10^{-6}$ in BL and $A=2 \times 10^{-4}$ in FT
- Coagulation
- Condensation of H_2SO_4

Radiation

*δ -four-stream
including ice cloud*

Cloud

Physics & Dynamics
4 types of Hydrometeors
(Q & N)

Chemistry

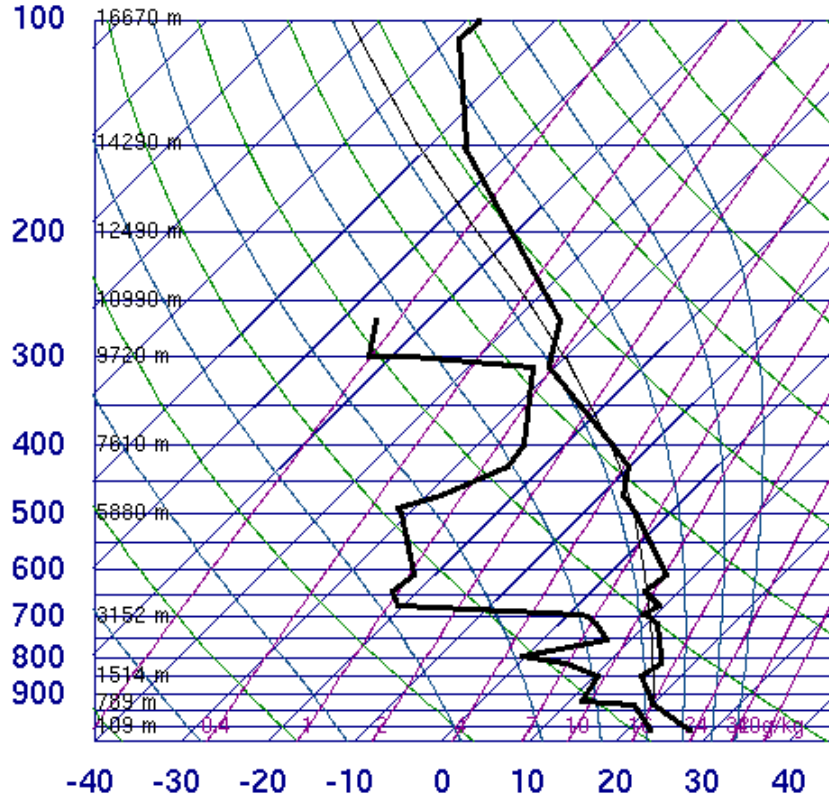
*Species: 25g+16c,r+7i
Reactions:
35g + 21eq + 32aq + 7h*

**References: Wang and Chang, 1993; Wang et al., 1995; Wang and Prinn, 2000;
Wang 2002; Ekman et al., 2004; Ekman et al., 2006**

Model initialization

Meteorology

81405 SOCA Rochambeau

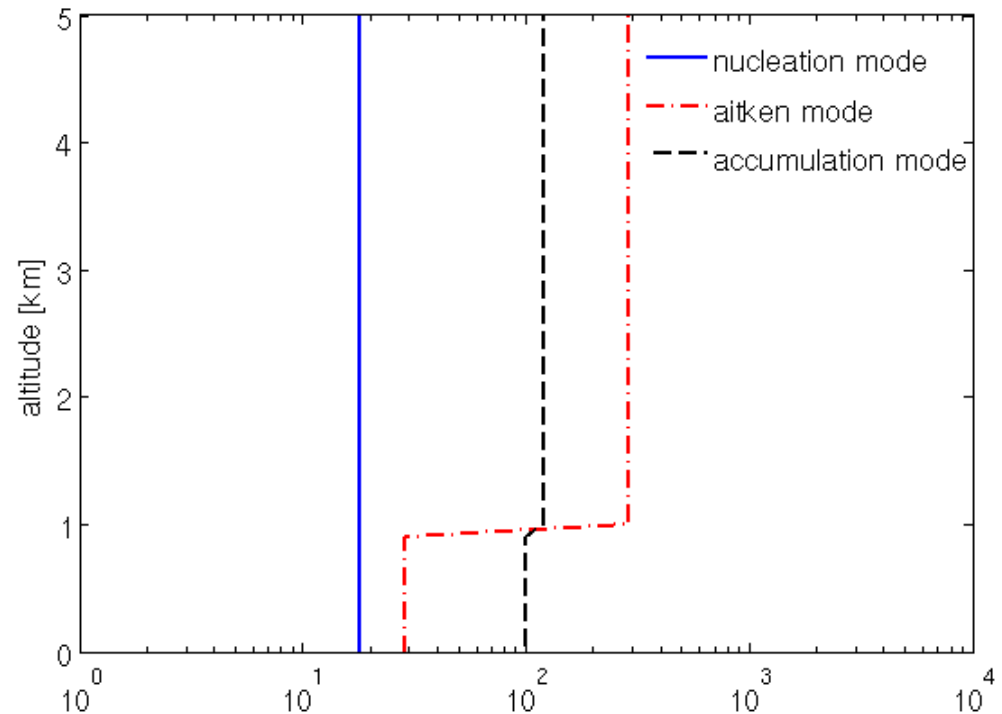


12Z 27 Mar 1998

University of Wyoming



Aerosol number concentration [cm⁻³]



Nuc mode:

$$0 \leq d \leq 10 \text{ nm}$$

Ait mode:

$$10 \leq d \leq 60 \text{ nm}$$

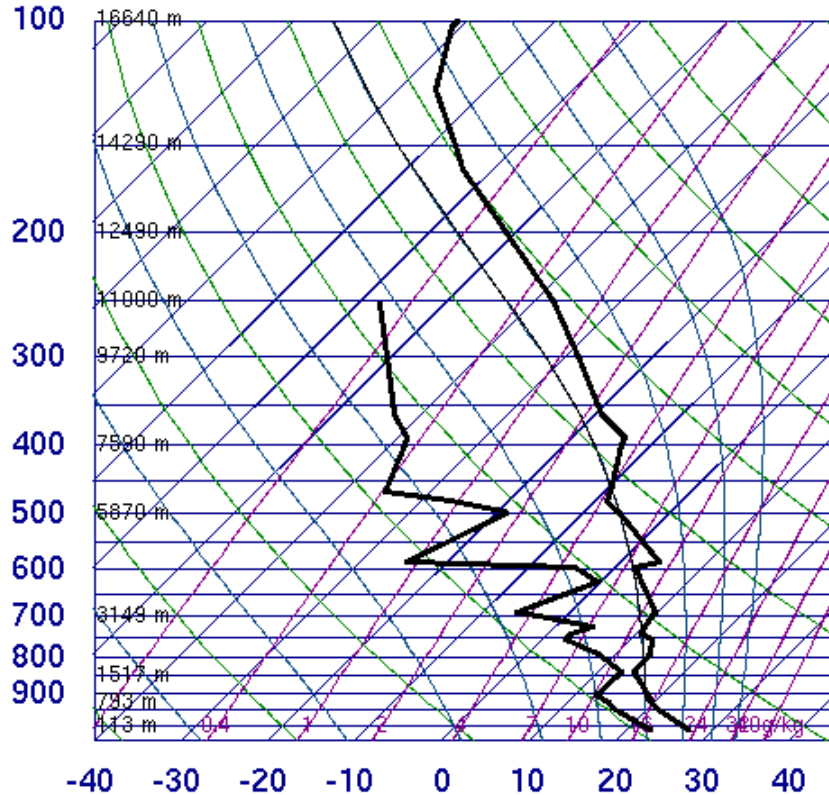
Acc mode:

$$60 \leq d \leq 250 \text{ nm}$$

Model initialization

Meteorology

81405 SOCA Rochambeau

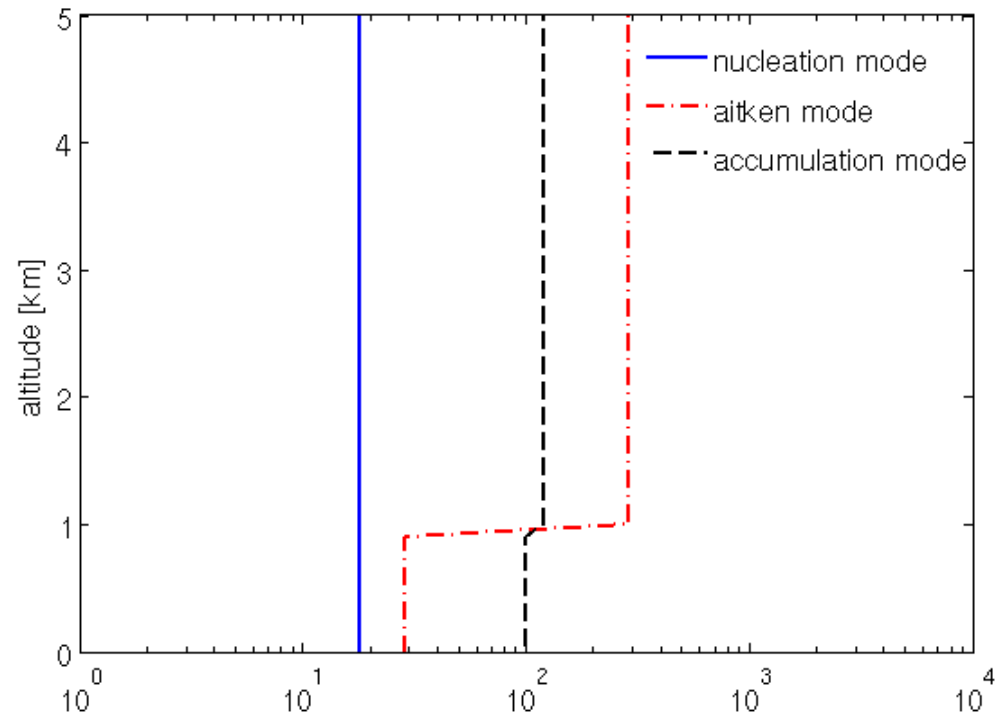


12Z 15 Mar 1998

University of Wyoming



Aerosol number concentration [cm⁻³]



Nuc mode:

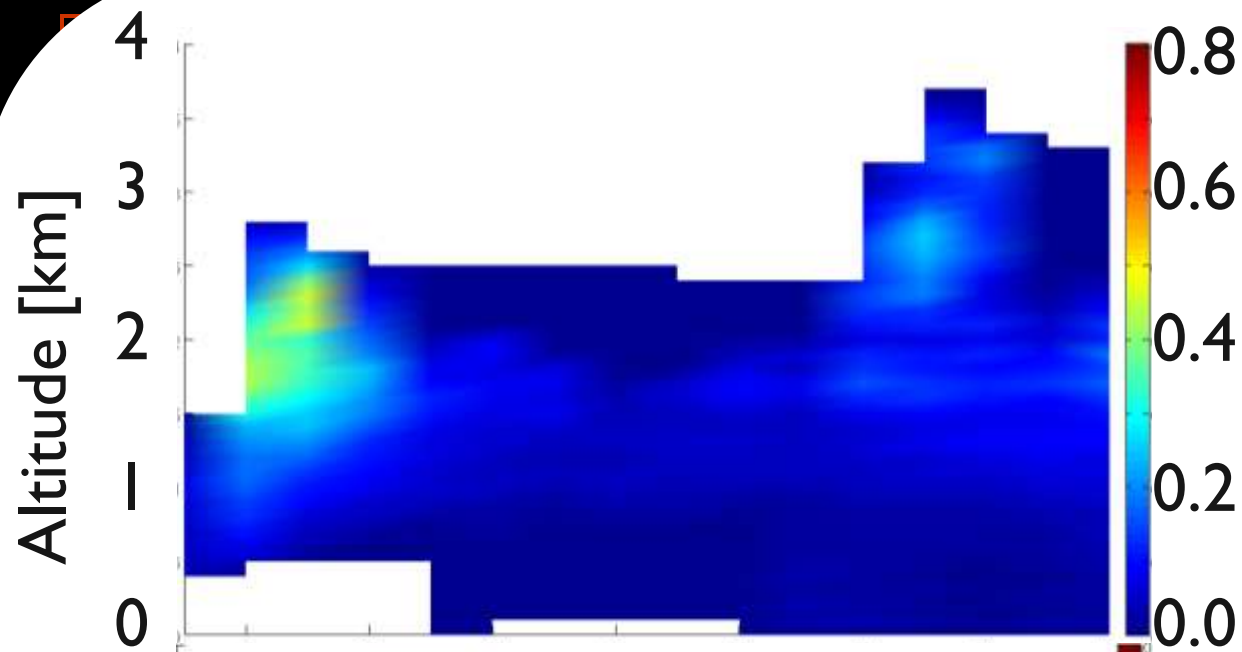
$$0 \leq d \leq 10 \text{ nm}$$

Ait mode:

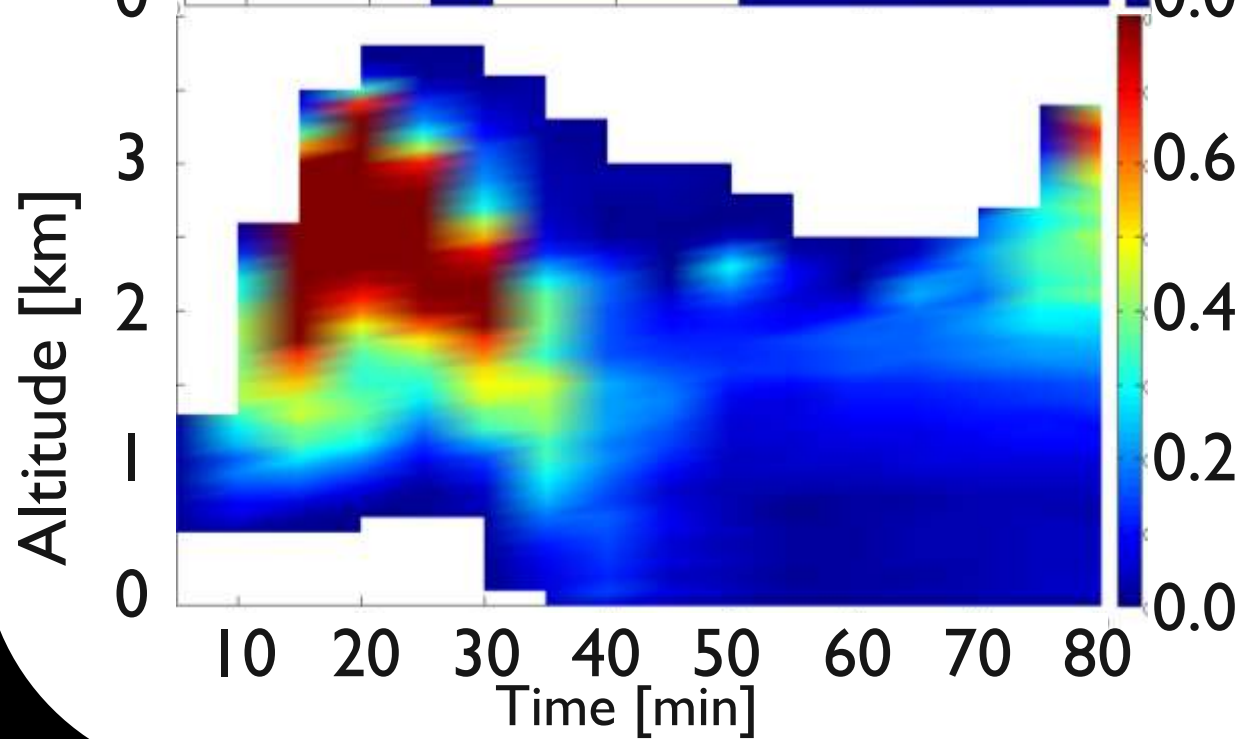
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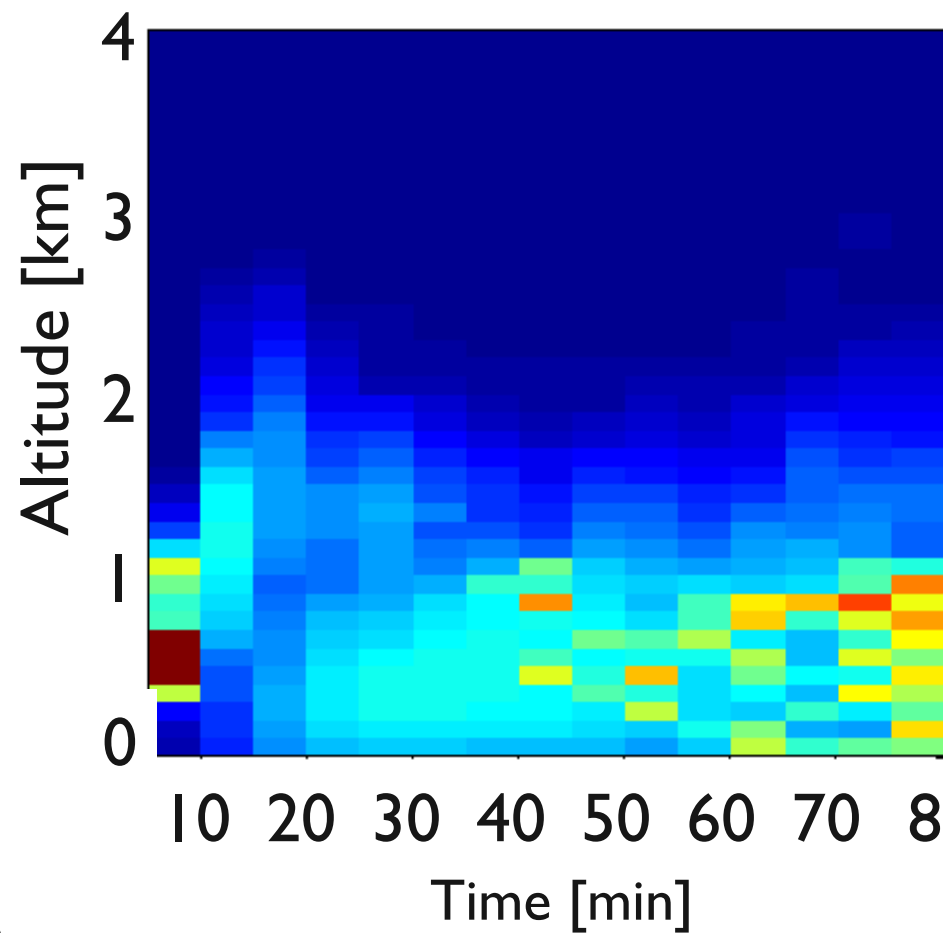


27th of March
Mean water content
 $[\text{gkg}^{-1}]$

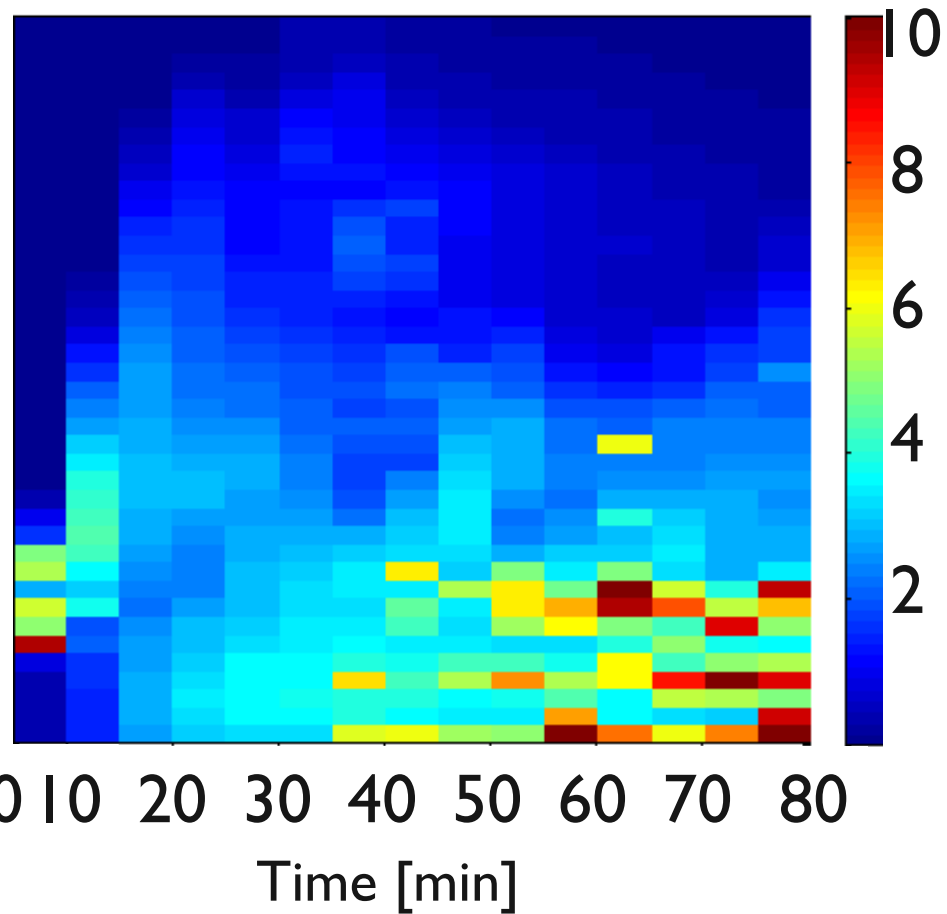


15th of March
Mean water content
 $[\text{gkg}^{-1}]$

27th of March
Maximum H_2SO_4
[ppt $\times 10^3$]



15th of March
Maximum H_2SO_4
[ppt $\times 10^3$]

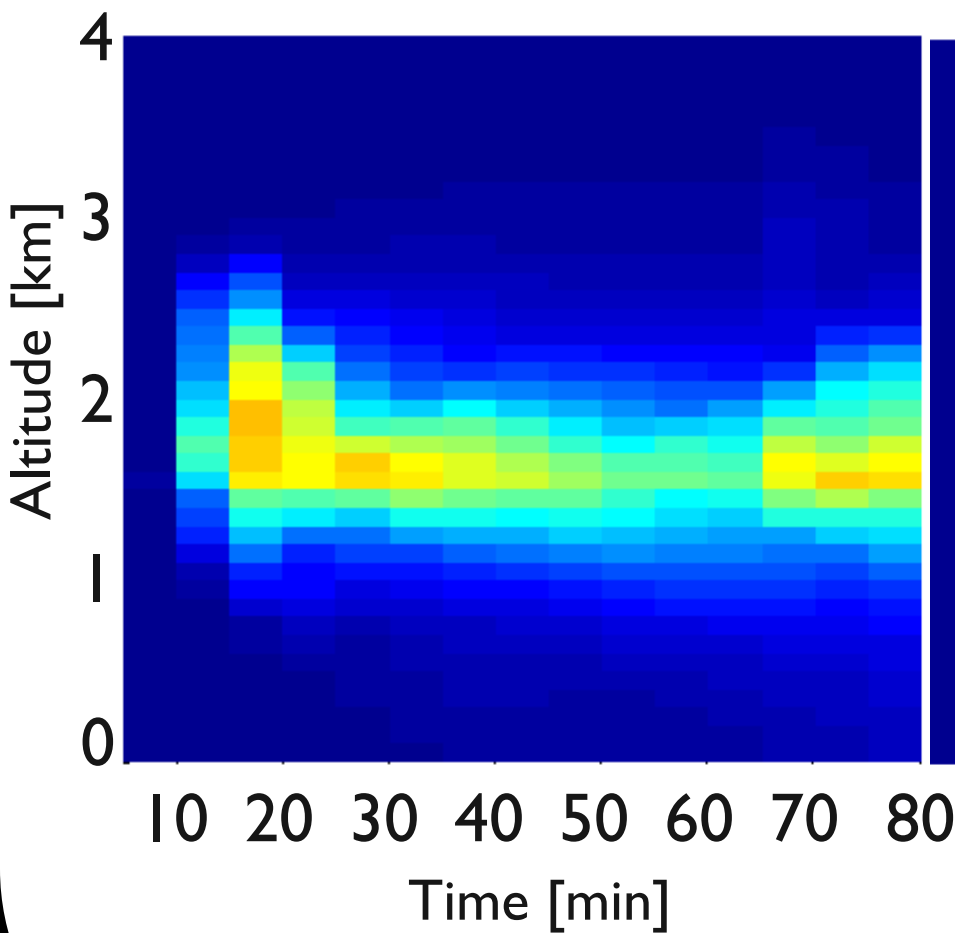


Sensitivity simulations

- Isoprene is assumed to have a background BL concentration of 4 ppbv
 - Isoprene can be transported, oxidized, dissolved, and scavenged within the cloud.
 - Isoprene is assumed to form a condensable oxidation product above 1.5 km of 0.2% (Claeys et al., 2004)
-

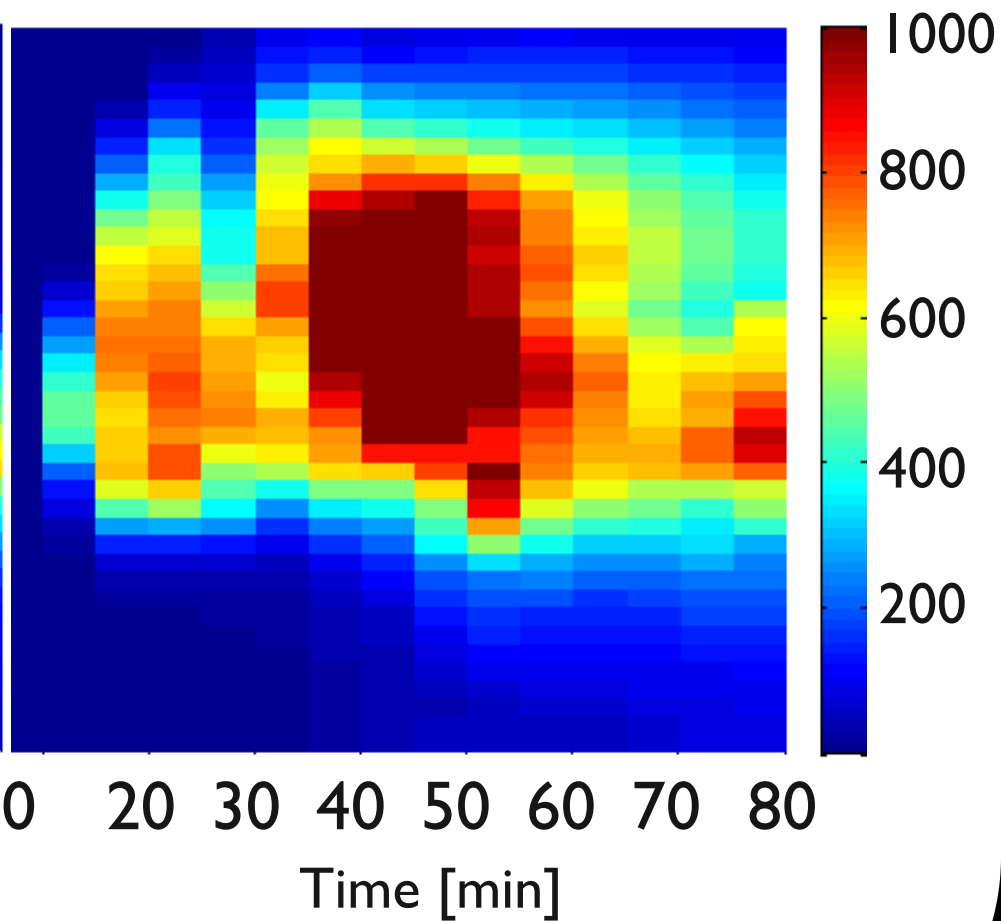
27th of March

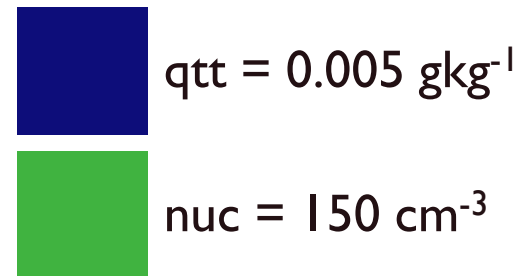
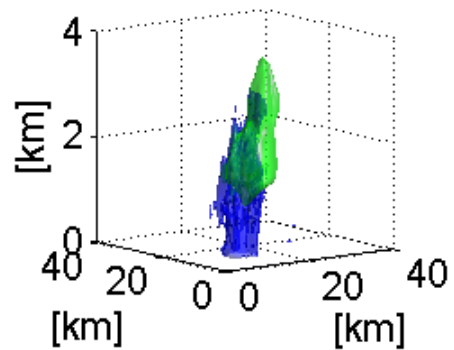
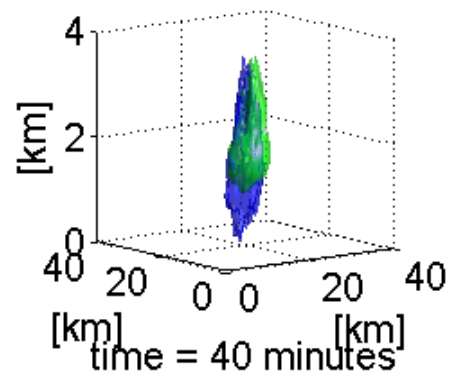
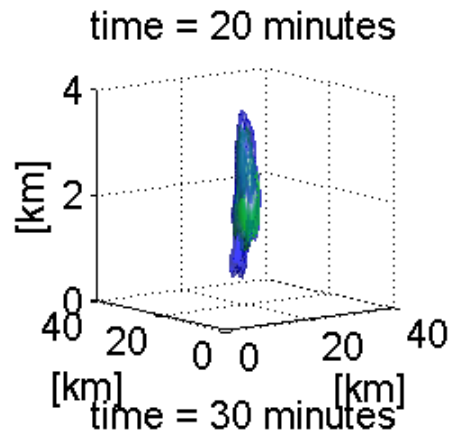
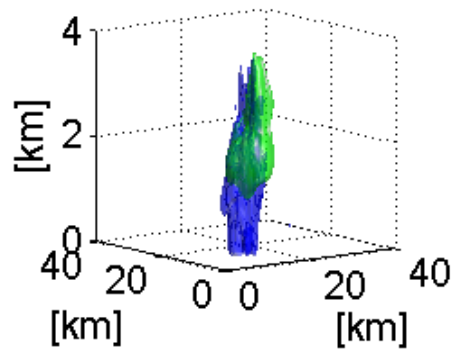
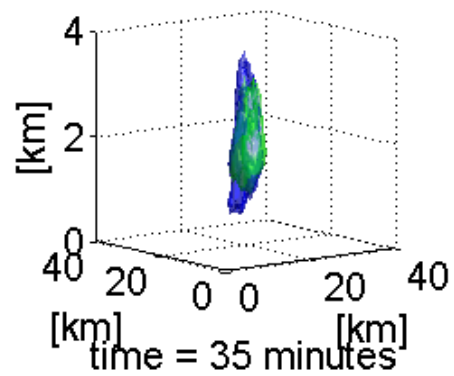
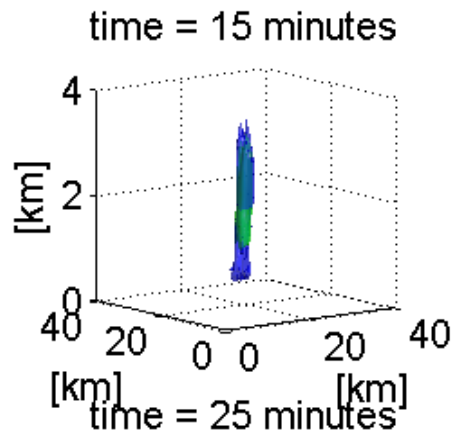
Maximum nuc mode number
[cm^{-3}]



15th of March

Maximum nuc mode number
[cm^{-3}]





Lagrangian calculations

$z = 4 \text{ km}$

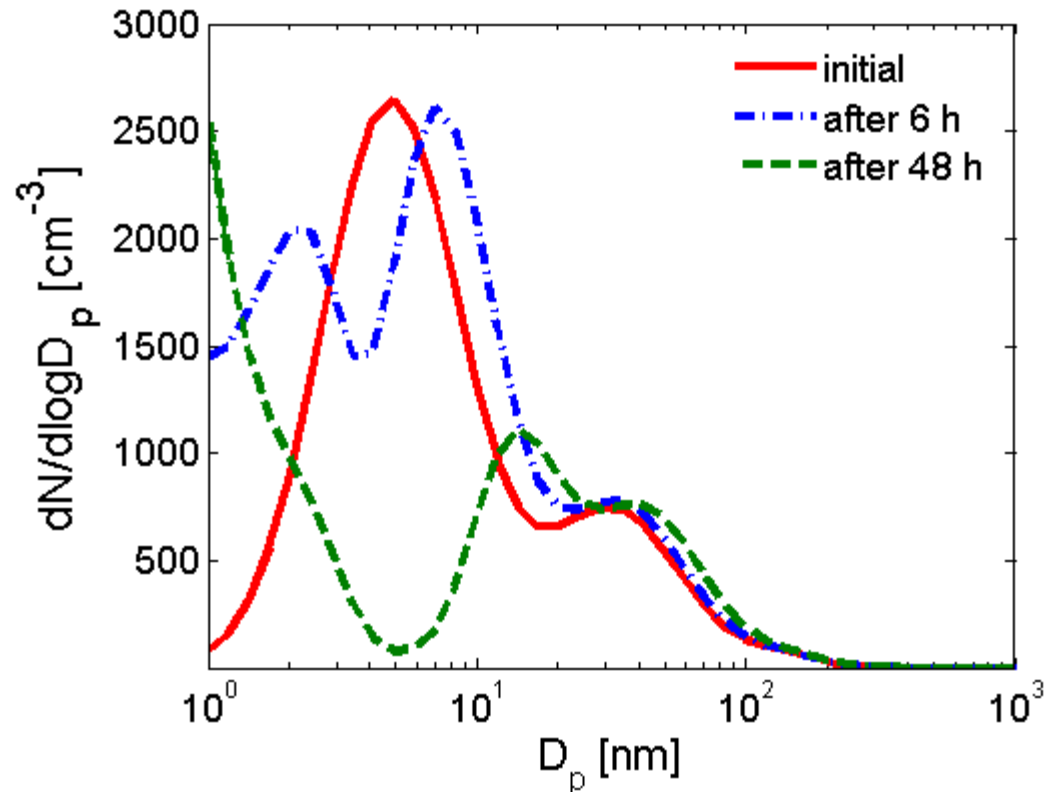
Isoprene = 200ppt

SOA yield = 0.8%

$\text{SO}_2 = 1.5\text{ppt}$

$A = 2e-6$

values re-stored every 24 h

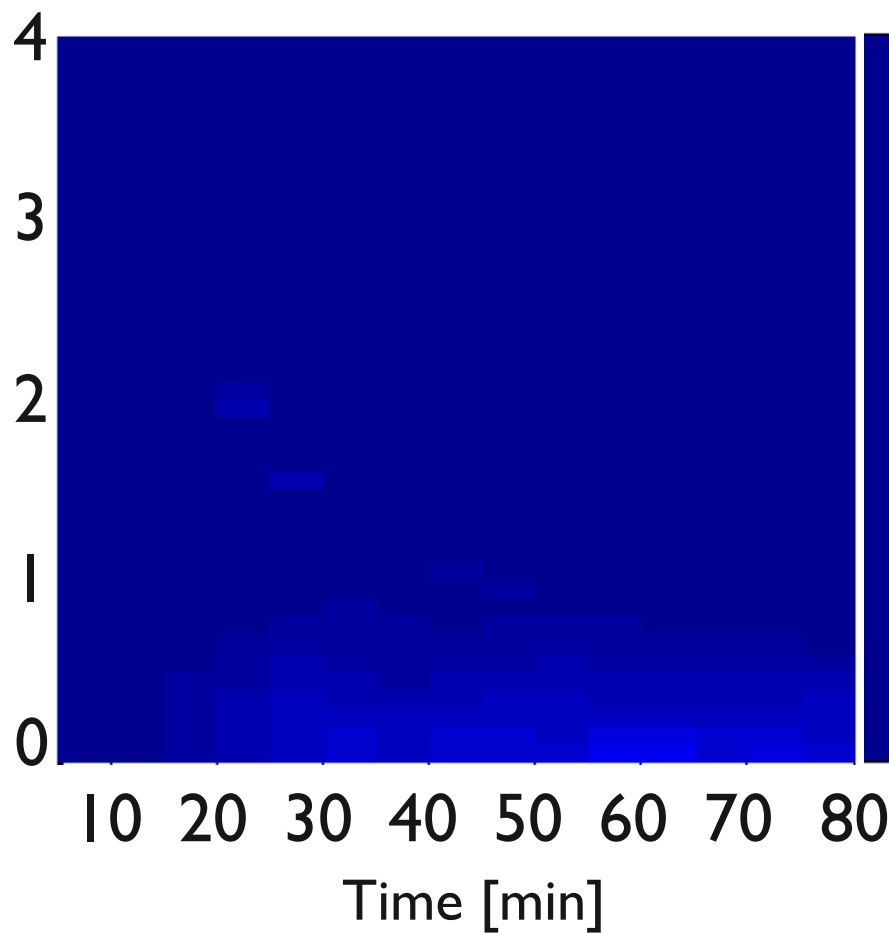


Conclusions

- New particles can form through mixing between the RL and ML, but the formation rate is small.
- New particles can form within shallow convective clouds over the Amazon basin (using activation nucleation + isoprene SOA yield of 0.2%).
- The shallow convection has to reach 3-5 km altitude for the formation to be efficient
- Some of the small aerosols can be transported by downdrafts into the BL.
- An SOA yield of 0.8% is needed for the aerosols to grow above 10-20 nm.

27th of March

Maximum Ait mode number
[cm^{-3}]



15th of March

Maximum Ait mode number
[cm^{-3}]

